

2014 DRY BEAN YIELD TRIALS

J.D. Kelly, E. Wright, N. Blakely, and J. Heilig

Plant, Soil and Microbial Sciences

The dry bean breeding program initiated its sixth season at the 320 acre Saginaw Valley Research & Extension Center (SVREC) research farm near Frankenmuth in 2014. A total of 2,742 yield trial plots (20 tests) were harvested in 2014 and ~3000 single plant selections were made in the early generation nurseries. Yield trials at SVREC included 36-entry standard navy test; 30-entry standard black test; 48-entry prelim navy tests; 36-entry and 72-entry prelim black tests; 36-entry standard GN; 30-entry standard pinto test; 36-entry standard red/pink test; 32-entry prelim GN test; 40-entry, 80-entry, and 56-entry prelim red tests; 24-entry drought trial and 48-entry Co-op and regional test that includes pinto, GN, red and pinks. At the Montcalm Research Farm near Entrican yield trials included 30-entry bush cranberry test; 36-entry kidney test; 30-entry preliminary kidney test; and 64-entry white mold test. Two 36-entry certified organic trials were conducted in Tuscola and Sanilac counties. All trials were direct harvested except for kidney and cranberry beans at Montcalm.

Bean yields at SVREC were exceptional in 2014 averaging 35 cwt/acre with top yields exceeding 50 cwt in some trials. Temperatures were moderate not exceeding 90F and rainfall for 4-summer months was 2.2 inches above the 30-year average. The extra rainfall was well distributed with most falling in July so there was no stress to the crop due to limited moisture or high temperatures at the critical flowering period. White mold was a serious problem in the commercial crop and on adjacent farms but not in research plots where the extra tile drainage allowed for more rapid drying of the soil surface following rain. The trials at SVREC received no post herbicide treatment or any insecticide or fungicide treatments in 2014. The highest yield potential was in the preliminary black and small red trials and the navy beans underperformed in 2014. Overall the top yielding navy lines were generally later, and did not exhibit the best dry down at maturity. The new black bean variety Zenith was the top yielding cultivar in all trials. There was a fairly severe outbreak of common bacterial blight and the greatest damage occurred in the medium seeded great northern and pinto trials. Good levels of resistance were observed in the pink bean trials and in some of the new black bean lines.

Plots at Montcalm had similar rainfall pattern as SVREC but the supplemental irrigation did contribute to the development of white mold. Incidence in the National Sclerotinia Initiative nursery was very high in the susceptible checks and proved to be an excellent screening nursery. The major problem at Montcalm was the presence of severe root rots mainly *Fusarium* that was accentuated by the wet and cooler soil conditions early in the season. In disease samples sent for lab analysis, *Pythium* species were detected in addition to *Rhizoctonia solani* and various *Fusarium* species including *F. oxysporum* or wilt and *F. solani* complex. Despite the severe disease pressures, yields in kidney beans approached 40 cwt/acre and many lines with tolerance to root rot and with resistance to common bacterial blight were identified in kidney bean nurseries. The wet conditions caused a delay in applying post herbicide treatments and additional nitrogen was applied as a side dress to help overcome early problems with root diseases. Deer feeding was a major problem in the trials and will need to be addressed in future years. The white mold trial was direct harvested while the standard kidney and cranberry trials were pulled and windrowed.

The data for all tests are included in an attached section. Procedures and details on nursery establishment and harvest methods are outlined on the first page. Since the data collected on each test are basically the same, a brief discussion of each variable measured is presented below for clarification purposes.

1. Yield is clean seed weight reported in hundredweight per acre (cwt/acre) standardized to 18% moisture content. Dry beans are commercially marketed in units of 100 pounds (cwt).
2. Seed weight is a measure of seed size, determined by weighing in grams a pre-counted sample of 100 seeds, known as the 100-seed weight. To convert to seeds per 100g (10,000/100 seed wt); for example 100-seed weight of 50 converts to 200 seeds per 100 g (used in marketing).
3. Days to flower are the number of days from planting to when 50% of plants in a plot have one or more open flowers.
4. Days to maturity are the actual number of days from planting until date when all the plants in a plot have reached harvest maturity.
5. Lodging is scored from 1 to 5 where 1 is erect while 5 is prostrate or 100% lodged.
6. Height is determined at physiological maturity, from soil surface to the top of plant canopy, and is recorded in centimeters (cm).
7. Desirability score is a visual score given the plot at maturity that takes into consideration such plant traits as; moderate height, lodging resistance, good pod load, favorable pod to ground distance, uniformity of maturity, and absence of disease, if present in the nursery. The higher the score (from 1 to 7) the more desirable the variety, hence DS serves as a subjective selection index.

At the bottom of each table, the mean or average of all entries in a test is given to facilitate comparisons between varieties. In order to better interpret data, certain statistical factors are used. The LSD value refers to the Least Significant Difference between entries in a test. The LSD value is the minimum difference by which two entries must differ before they can be considered significantly different. Two entries differing in yield by 1 cwt/acre cannot be considered as performing significantly different if the LSD value is greater than 1 cwt/ acre. Such a statement is actually a statement of "probable" difference. We could be wrong once in 20 times ($p=0.05$) on the average, depending on the level of probability. The other statistic, Coefficient of Variation (CV), indicates how good the test was in terms of controlling error variance due to soil or other differences within a location. Since it is impossible to control all variability, a CV value of 10% or less implies excellent error control and is reflected in lower LSD values. Under the pedigree column, all released or named varieties are **bolded** and always preceded by a comma (,); when preceded by a slash (/), the variety was used only as a parent to produce that particular breeding line.

Expt. 4101: Standard Navy Bean Yield Trial

This 36-entry trial included standard commercial navy bean varieties, and advanced lines from the MSU breeding program, which carry the N-prefix. Yields ranged from 26.2 to 40.8 cwt/acre with a mean of 34.9 cwt/acre. The trial was fairly uniform and variability was well controlled (CV=9.9%) and the LSD needed for significance was 4.1 cwt/acre. Only four entries significantly out-yielded the test mean and included two top yielding lines from 2013 navy trials. The newly released variety Alpena performed well, slightly out yielding Merlin and Medalist by ~2 cwt/acre and significantly out yielded Vista and Indi. The line continues to dry down well in contrast to other current varieties that retain green stem at harvest. The new OAC variety Fathom was comparable to Hyland T9905, but with lower agronomic desirability rating due to lodging problems. Canning tests will be conducted on all new MSU breeding lines before being considered for release.

Expt. 4102: Standard Black Bean Yield Trial

This 30-entry trial included the standard commercial black bean varieties and advanced breeding lines. Yields ranged from 28.2 to 46.1 cwt/acre with a test mean of 37.3 cwt/acre. Variability was low in this test, (CV=7.6%) and the LSD was 3.3 cwt/acre. Eight entries significantly outyielded the test mean and these included a new line ND071206 from NDSU. These lines had a mixed range of backgrounds with parents from CIAT, Puerto Rico and NDSU and some lines had seed sizes outside the normal range for black beans. Zorro fell outside this group and below GTS-1103, Shania, and Eclipse in performance. The new release Zenith, which was the top yielding entry in 2011-13 ranked below Zorro this season due to higher pressure from common bacterial blight in this trial. Zenith exhibits an excellent combination of high yield potential, erectness, dry down and superior canning quality. Canning tests will be conducted on breeding lines to ensure only those with canning quality similar to Zenith are advanced.

Expt. 4103: Preliminary Navy Bean Yield Trial

This 48-entry trial included new navy bean lines and check varieties. Yields ranged from 31.8 to 45.1 cwt/acre with a mean of 39.3 cwt/acre. Variability was low in this 3-rep test (CV=7.1%) and the LSD was 3.8 cwt/acre and overall yields were better than advanced navy trial 4101. Three lines significantly outyielded the test mean. Merlin was the highest yielding variety ahead of Alpena and Medalist in the trial. This trial exceeded the yield of the standard navy trial by 5 cwt and suggested the high yield potential of these new lines. Future advances of many of the new breeding lines will largely depend on disease reactions and canning quality of the entries.

Expt. 4104: Preliminary Black Bean Yield Trial

This 36-entry trial included new black bean lines and check varieties. Yields ranged from 8.8 to 51.3 cwt/acre with a mean of 34.3 cwt/acre. Test 4104 was the top yielding test in 2014. Variability was high in this 3-rep test (CV=14.0%) and the LSD was large at 6.5 cwt/acre. Seventeen lines significantly outyielded the test mean and the top yielding entry produced an all-time high yield for the SVREC farm. Zenith was the top yielding variety followed by Zorro, Shania, and Jaguar. This trial also included a series of non-nodulating black breeding lines derived from crossing Zorro

with non-nodulating navy bean R99. These lines were developed with the intent they might provide a useful black bean check for future biological nitrogen fixation studies, but proved to be poorly suited to field conditions and will be discarded. Their poor performance contributed to the higher variability present in this trial. Many of the lines in this trial carry anthracnose resistance but future advances of any new breeding lines will largely depend on confirmation of disease reactions and canning quality of the entries.

Expt. 4106: Standard Great Northern Bean Yield Trial

This 36-entry trial included MSU great northern breeding lines (G-prefix) and standard commercial check varieties and otebo bean lines. The test ranged in yield from 17.4 to 34.8 cwt/acre with a mean yield of 28.1 cwt/acre. Variability was moderate (CV= 11.0%) resulting in a LSD value of 3.6 cwt/acre needed for significance. Five breeding lines significantly outperformed the test mean and included the otebo breeding line G12901 and four GN lines, two of which were derived from crosses with Eldorado pinto. Matterhorn yielded just above the test mean, and 3 cwt/acre above Powderhorn. Fuji otebo was the lowest yielding entry, underscoring the need for new upright varieties in the otebo class such as G12901 that produced nearly double the yield in this trial. G12901 is the first upright type-II otebo bean as previous varieties like Fuji are bush types. It shows outstanding performance and would be suitable for direct harvest. The line will continue to be tested for yield and quality traits, and its suitability in 'An' confectionary paste prior to any decision on release.

Expt. 4107: Standard Pinto Bean Yield Trial

This 30-entry trial included standard commercial pinto bean varieties Eldorado and La Paz, and advanced breeding lines from the MSU breeding program with the P-prefix. The trial ranged in yield from 29.0 to 39.5 cwt/acre with a mean of 34.7 cwt/acre. Variability was moderate (CV=10.8%) in this trial and the LSD needed for significance was 4.4 cwt/acre. The top yielding variety Eldorado was the only entry that significantly out-yielded the test mean at 39.5 cwt/acre. La Paz ranked 10th in the trial yielding 36.0 cwt/acre. The remainder of the top 10 highest yielding entries were new P14 lines. This group included two groups of sibling families, one derived from crossing with CSU variety Long's Peak and the other with leafhopper tolerant breeding lines. Eldorado continues to show its yield potential: was 2nd in 2010 and 2013 and 1st in 2011, 2012, and 2014. Only those high-yielding entries with more upright architecture and canning quality equivalent to Othello will be advanced in 2015.

Expt. 4108: Standard Pink and Small Red Bean Yield Trial

This 36-entry trial included small red and pink breeding lines from MSU (R-small red; S-pink prefix), in addition to standard commercial check varieties. The test ranged in yield from 27.5 to 44.5 cwt/acre with a mean yield of 35.0 cwt/acre. Variability was low (CV=7.7%) resulting in a LSD value of 3.2 cwt/acre for significance. Nine breeding lines including private small red line SR09303 and MSU pink variety Rosetta significantly outperformed the test mean. Sibling family R12843-45 were among three of the top six yielding lines; two of the siblings were also the top yielding MSU small red lines in the 2013 trial. Three new S14 lines were also among the group that significantly exceeded the test mean. Small red variety Merlot yielded equivalent to the test

mean, while pink variety Sedona yielded below test mean and significantly lower than new pink variety Rosetta. Many of the pink lines showed high levels of resistance to common blight. Merlot had an overall poor performance year combined with delayed maturity in many locations similar to 2011-2013. Progress in small red breeding program has been limited by a lack of useful variability and inability to combine performance with upright architecture, disease resistance and suitable canning quality in new lines. All lines will be evaluated for canning quality and BCMV reaction prior to advancing to 2015 trials.

Expt. 4109: Preliminary Great Northern Bean Yield Trial

This 32-entry trial included new great northern bean lines and otebo lines along with check varieties. Yields ranged from 25.8 to 46.8 cwt/acre with a mean of 38.8 cwt/acre. Variability was well controlled in this 3-rep test (CV=4.6%) and the LSD was 2.4 cwt/acre. Eight lines significantly out-yielded the test mean, with top yielding entry derived from a cross with Eldorado pinto demonstrating its potential as a parent to enhance yield in the GN class, similar to results observed in 2013. Matterhorn and Powderhorn checks yielded below the test mean and Matterhorn out performed Powderhorn in 2014. Otebo beans G12901 and Fuji were also included in this test, and G12901 yielded 37.3 cwt/acre, equivalent to Powderhorn GN, whereas Fuji was the lowest yielding entry at 25.8 cwt/acre. Future advances of many of the new breeding lines will largely depend on disease reactions and canning quality of the entries.

Expts. 4110, 4111, 4112: Small Red Bean Genetic Yield Trials

The three genetic studies were conducted as yield trials to evaluate three recombinant inbred line (RIL) populations consisting of 40 (4110); 80 (4111) and 56 (4112) individuals. The populations were derived from crosses between Merlot and SER95 (4110); SER48 (4111); and SER94 (4112). The SER lines were developed at CIAT Colombia as sources of drought tolerance in the small red seed type. Yields ranged from 14.6 to 41.6 cwt/acre with a mean of 28.5 cwt/acre in test 4110. Variability was moderate in this 3-rep test (CV=10.2%) and the LSD was 4.0 cwt/acre. Eleven lines significantly out-yielded the test mean including the Merlot variety. The SER lines yielded below the test mean. Yields ranged from 18.8 to 42.7 cwt/acre with a mean of 30.8 cwt/acre in test 4111. Variability was moderate in this 3-rep test (CV=8.9%) and the LSD was 3.7 cwt/acre. Fifteen lines significantly out-yielded the test mean but did not include the Merlot variety. The SER lines yielded below the test mean. Top yielding entry R13752 was the third highest yielding line from this test in 2013. Yields ranged from 22.3 to 50.5 cwt/acre with a mean of 35.6 cwt/acre in test 4112. Variability was moderate in this 3-rep test (CV=8.8%) and the LSD was 4.2 cwt/acre. Fourteen lines significantly out-yielded the test mean. R12844 was top yielding entry at 50.5 cwt/acre, significantly out performing commercial check Merlot by 13.7 cwt/acre. The SER lines yielded below the test mean. All these lines mature very early and do not yield up to the Merlot check, despite possessing drought tolerance. The entries in all three tests behaved very similarly and data will be analyzed to identify QTL associated with yield in all three populations. Some lines with acceptable seed quality will be entered in the standard small red yield trials in 2015.

Expt. 4113: Combined Midwest Regional Performance Nursery (MRPN) & Cooperative Dry Bean Nursery (CDBN) Yield Trial

The MRPN is conducted annually in cooperation with North Dakota (ND-prefix), Nebraska (NE-prefix) and Colorado (CO-prefix) in order to test new pinto and great northern lines from all four programs and assess their potential in the different regions. The CDBN is a national trial and includes all classes but only medium-sized entries were included in this trial. The 48-entry trial ranged in yield from 19.3 to 47.8 cwt/acre with a mean of 35.4 cwt/acre. Variability was low (CV=7.0%) resulting in a LSD value (3.4 cwt/acre) for significance. As a result thirteen lines were significantly higher in yield than the test mean including the MSU varieties Eldorado and Powderhorn, the new Flor de Mayo variety Gypsy Rose and the private variety La Paz. In the top group were pinto, great northern, small red from MSU, USDA-WA, Colorado, and Idaho. Several new slow darkening pintos SF103-8, 23ST-27 from NDSU, and L11PS-series from Gentec were included in this trial. The NDSU lines exhibited upright habit better suited to MI conditions with average yield potential. The Gentec lines closely resembled the variety Othello. The new tebo line G12901 significantly outyielded current variety Fuji in this trial by a margin of 10 cwt/acre. This cooperative trial continues to be valuable as it allows an evaluation of potential new lines prior to release in other states and confirmed performance of new MSU varieties released in 2014. Canning quality will also be evaluated for all entries in this trial.

Expts. 4914 & 4915: Organic Dry Bean Yield Trials

Two 36-entry yield trials were conducted on certified organic grower farms in Tuscola and Sanilac counties following standard organic agronomic practices. Entries in these trials consisted of a diverse mix of bean breeding lines and commercial varieties across 12 seed types. Previous organic trials have consisted of only navy and black beans, but additional seed types were added this year to evaluate if they were suited to organic production systems and could offer viable alternatives to organic growers. Both trials were planted mid-June and enjoyed plentiful soil moisture and moderate temperatures.

Test 4914 suffered from excessive rainfall in July that damaged parts of the trial, leading to higher variability (CV=18.2%) and LSD (4.7cwt/acre). White mold was also a contributing factor, with moderate disease severity. Grasses were the predominant weed control challenge. Yields ranged from 14.7-31.5cwt/A with a mean of 21.9cwt/acre. Eldorado pinto produced the highest yield, while a range of black, pinto, and small red breeding lines also yielded > 25cwt/acre. The pink bean Rosetta was the second highest yielding commercial variety at 25.6 cwt/acre. The three kidney bean varieties were among the lowest performers, suggesting they may be more challenging to produce in this region under organic conditions.

Test 4915 was less variable (CV=11.2%) resulting in a lower LSD (1.8cwt/acre), although yields were generally lower with a trial mean of 13.7cwt/acre. Severe white mold infection greatly reduced yields, despite the more vigorous plant growth compared to the Caro plot. Broadleaves (lambsquarter, pigweed, nightshade) were the predominant weeds present. Harvest conditions were challenging, and further decreased measured yield. Eldorado pinto was also the highest yielding variety at this location, but a range of commercial varieties performed well including Rosetta pink, Zenith black, Merlot small red, Powderhorn great northern, and Merlin navy with yields in the 17.5-22 cwt/acre range. Kidney beans were also lower yielding in this trial, although the new white kidney Snowdon significantly outyielded the other two kidney

bean varieties. Overall these trials suggest that there are current commercial varieties in a range of seed classes that are suited to organic production conditions and could be grown in addition to the current focus on organic black beans.

Expt. 4216: Standard Kidney Bean Yield Trial

This 36-entry trial was conducted on the Montcalm Research Farm (MRF) to compare the performance of standard and new light red kidney (LRK), dark red kidney (DRK) and white kidney (WK) bean varieties from MSU and CDBN under supplemental irrigation (4x total 2.70"). A group of yellow bean breeding lines from both MSU and OSU were also tested. Yields ranged from 14.1 to 39.6 cwt/acre with a mean of 32.4 cwt/acre. Variability was moderate (CV=8.5%) resulting in a LSD value of 3.7 cwt/acre needed for significance. Eight breeding lines significantly out-yielded the test mean, including DRK, LRK, WK, and yellow lines. The top yielding entry K11306 appears to have resistance to root rot and is under consideration for advancement. The program is becoming interested in yellow beans and Y11405 was among the top yielders. Four yellow beans from OSU (DBY-code) were evaluated in 2014 and despite showing poor adaptation, floppy growth habit and pale yellow seed color, two lines yielded with Clouseau and Snowdon, while the other two fell at the bottom of the trial. The DBY-lines carry resistance to BCMV whereas Y11405 is susceptible. Clouseau, Snowdon, CELRK, and new NDSU DRK variety Talon yielded above the test mean, whereas Yeti, Red Hawk, GTS-104, Redcoat, Beluga, Majesty, Montcalm and Inferno were below the mean. Majesty produced a seed size of 84 g compared to 67g for Montcalm. The most severe disease pressure in the trial was severe root rot (Fusarium) brought on by cool wet conditions following planting. Prevalence of root rot severely reduced stands and overall early season vigor in many plots, but lines with tolerance to the disease were identified. New LRK variety Rosie from NDSU was the lowest yielding variety in the trial, suggesting it may not be well adapted to MI. Since canning quality is vital in kidney beans, only those DRK lines equivalent in canning quality to Red Hawk, LRK lines equal or better than CELRK and WK lines equivalent to Beluga will be advanced in 2015.

Expt. 4217: Preliminary Kidney Bean Yield Trial

This 30-entry trial was conducted on the MRF to compare new and standard kidney bean varieties under supplemental irrigation (4x total 2.70"). Yields ranged from 23.4 to 42.3 cwt/acre with a mean of 34.9 cwt/acre. Variability was moderate (CV=8.5%) in this 3-rep test and the LSD needed for significance was 4.1 cwt/acre. Seven lines significantly out-yielded the test mean and included Snowdon and Clouseau. Several progeny of Snowdon were among the top yielding lines, with both WK and LRK seed types. New DRK lines were generally lower yielding, and the variety Red Hawk also yielded below the test mean. The low yielding entry K11925 was the largest seeded fabada line (102g) illustrating the difficulty of combining yield with large seed size. Only those entries with acceptable seed size and canning quality will be advanced in 2015.

Expt. 4218: Standard Bush Cranberry Bean Yield Trial

This 30-entry trial was conducted on the MRF to compare new and standard bush cranberry bean varieties under supplemental irrigation (4x total 2.70”). Yields ranged from 22.5 to 43.4 cwt/acre with a mean of 33.9 cwt/acre. Variability was low (CV=7.1%) and the LSD needed for significance was 3.3 cwt/acre. Six lines significantly out-yielded the test mean, including three new breeding lines and the Etna check. These include a family of lines with superior agronomics but lack the large seed size (57g) needed in the cranberry market class. Etna had the largest seed size at 75 g/100 seed. Overall the cranberry beans on the farm were the most damaged by root diseases in 2014 and the class lacks genetic potential due to its very narrow genetic base. Only those entries equivalent to Etna in seed size with improved yield, earlier maturity and canning quality will be advanced in 2015.

Expt. 4219: National White Mold Variety Yield Trial

This 64-entry trial was conducted at Montcalm to evaluate a range of diverse dry bean varieties and breeding lines for reaction to white mold under natural field conditions. Genotypes included commercial navy and black bean cultivars, elite MSU lines, and new sources of white mold resistance entered as part of the National *Sclerotinia* Initiative (NSI) Nursery. Lines in the National trial were developed at MSU, NDSU, USDA-WA and Europe. Entries were planted in two row plots with two rows of susceptible spreader variety Matterhorn between plots and were direct harvested. Supplemental overhead irrigation was applied 6 times for a total of 4.00” to maintain adequate levels of moisture for favorable disease development at the critical flowering period. Natural white mold infection occurred across the entire trial and was extremely severe in certain plots. White mold was rated on a per plot basis on a scale of 1 to 9 based on disease incidence and severity where 9 had 90+% incidence and high severity index. White mold ranged from 11.1 to 100% and pressure was high with a mean value of 48.6% in 2014. The test ranged in yield from 2.2 to 33.8 cwt/acre with a mean yield of 20.6 cwt/acre. Variability was high (CV=16.5%), thus a high LSD value (4.6 cwt/acre) was needed for significance. As a result 15 lines significantly out-yielded the test mean and included the Eldorado, Powderhorn, Rosetta, Zenith, and Zorro varieties. Among those lines exceeding the test mean were the new slow darkening pinto SF103-8 (Santa Fe ancestry) from NDSU, pinto line USPT-WM-12 from USDA-WA for the fifth year, great northern 031-A-11 from USDA-WA and otebo G12901 and R12844 top yielding small red from MSU. Kidney and cranberry entries, including resistant check G122, yielded poorly in this trial, largely due to stand problems associated with root rot and limitations with direct harvest. ASR1002 rice bean from Europe was the lowest yielding entry, largely due to tiny seed size and general lack of adaptation. As in past years pintos, great northern and reds dominated the entries at the top of trial, followed by blacks, navy and pink lines and large seeded kidney were among the lowest yielding in the test. The biggest surprise was the low yield of Merlin and Alpena navy bean varieties yielding less than Beryl with significantly less white mold infection. The root rot diseases may have damaged the small white seeded beans more than other classes as the top yielding navy only yielded 24cwt/acre. Overall the trial confirmed results from previous years (susceptible check-Beryl rated 99% WM) and this trial will continue to be part of the breeding effort to improve tolerance to white mold across all market classes.

4120: National Dry Bean Drought Nursery

This 24-entry trial was conducted at the SVREC to evaluate a series of breeding lines identified as possessing improved levels of drought stress through shuttle breeding efforts between University of Nebraska and Tropical Agriculture Research Station (TARS) in Puerto Rico. The trial was replicated by colleagues at four locations across the U.S and P.R. The seed types ranged from small blacks and reds to great northern types. Yields ranged from 19.8 to 43.2 cwt/acre with a mean of 33.5 cwt/acre. Variability was moderate (CV=11.4%) and the LSD needed for significance was 5.3 cwt/acre. Seven lines significantly out-yielded the test mean, including varieties Zenith, Stampede, Powderhorn, and Zorro. Matterhorn also yielded above the mean, while Merlot ranked below the mean and equivalent to GN variety Marquis. Although conditions were ideal this season and plots suffered no heat or drought stress, the highest yielding breeding line was SB-DT1, identified previously as possessing drought tolerance. TARS-MST1, also known to tolerate multiple abiotic stresses, ranked just below Zorro. These results are encouraging as they suggest these lines developed specifically to tolerate stress also have similar yield potential as the local checks when grown under ideal conditions. The group at MSU will continue to do more in depth physiological studies on the ten top entries.

Early Generation Breeding Material grown in Michigan in 2014

F3 through F5 lines

Navy and Black - 363 lines
Pinto - 72 lines
GN - 245 lines
Pinks and Reds - 32 lines
Kidneys (DR, LR, White) - 51 lines

F2 populations

Navy and Black -164 populations
Pinto - 68 populations
GN - 100 populations
Pinks and Reds - 104 populations
Kidneys (DR, LR, White) – 337 populations
Yellow – 18 populations

F1 populations: 839 different crosses among ten contrasting seed types.